Why you can't afford to wait on CFC substitutes
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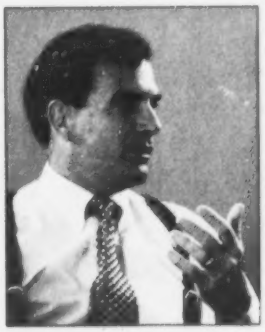
How flexible factories can pay off today *and* tomorrow
PAGE 58

A CAHNERS PUBLICATION

Electronic Business®

FOR THE MANAGEMENT TEAM IN ELECTRONICS, COMPUTER, AND SYSTEMS COMPANIES–WORLDWIDE SEPTEMBER 1992



"The biggest problem is that we don't really have an industrial policy that we can articulate... That has to change."

J. Daniel McCranie
Chairman and CEO
Seeq Technology

ELECTION REPORT '92

THE INDUSTRY SPEAKS OUT

"I'm not sure what an industrial policy is. I'd like to see a hell of a lot less regulation."

David Bossen
President and CEO
Measurex

A roundtable of seven executives discusses what Washington must do to assist the U.S. electronics industry. Here's their prescription

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Electronic Business

FOR THE MANAGEMENT TEAM IN ELECTRONICS, COMPUTER, AND SYSTEMS COMPANIES-WORLDWIDE

VOLUME 18, NUMBER 12 SEPTEMBER 1992

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Reinvigorating the U.S. economy—and the electronics industry—is a formidable challenge awaiting our next president. ELECTRONIC BUSINESS and the American Electronics Association gathered seven leading executives to examine what the U.S. government should and shouldn't do to assist electronics companies

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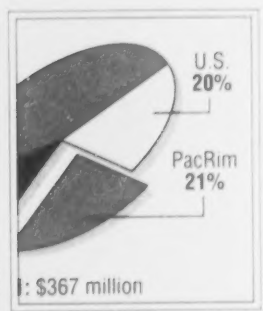

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The industry must get involved and start speaking more or less as one if it hopes to shuck its "political featherweight" image

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INTERNATIONAL

Asia's fastest-growing–and most profitable–electronics companies

Company	Growth 90/91	Company	Net income/ sales
Goldstar	23%	Nintendo	15.5%
Daewoo	20	Murata	9.7
Nintendo	19	Kyocera	6.0
Samsung Electron Devices	18	Pioneer	4.6
Samsung Electronics	16	TEL	4.2
Fujitsu	16	TDK	4.0

Source: ELECTRONIC BUSINESS

THANKS TO THE economic slump in Japan, sales by that country's largest electronics companies rose only about 5% in 1991, down from a 12% rise in 1990. That left Korean electronics makers looking especially strong: After two flat years, electronics sales by Korea's leading companies rose by 13%, to $21 billion. The top 50 electronics companies in the rest of Asia, as tracked by sister publication *Electronic Business Asia*, saw growth slip only slightly—from 19% in 1990 to 16% in 1991.

Most Asian companies' profits fell so far, however, that anyone that managed 4% margins looked good. Even at the Japanese companies that traditionally lead the industry, margins were mostly down 50% or so from 1990. Companies that fared better than average relied heavily on strong exports; Fujitsu's 17% growth, for example, came almost entirely from the computer business, and mostly from outside Japan.

a San Jose-based electronic-games maker, was sued by Japanese rival Sega for reverse-engineering a Sega Genesis video-game machine and several cartridges. A U.S. District Court in San Francisco upheld Sega's claim that Accolade illegally copied its software (see ELECTRONIC BUSINESS, August 1992, p. 9). If Sega wins the case, which could ultimately end up in the U.S. Supreme Court, the standard U.S. practice of reverse engineering may be history.

As part of the case, the IEEE filed a "friend-of-the-court" brief—only the fourth in its 108-year history—that backed Accolade's appeal by defending the concept of reverse engineering. IBM and Apple filed their own briefs defending Sega.

Shortly thereafter, attorneys for the two U.S. computer giants apparently convinced the IEEE to withdraw its support of Accolade. IEEE president Merrill Buckley, Jr. signed a three-sentence petition telling the court that its previous application to file the brief was "in error." Buckley contends that the Institute had incorrectly read its bylaws when it sanctioned the original brief.

The episode has kicked off a fire storm. "The IEEE never before allowed corporate pressure to influence its decisions," says Arv Larson, vice president of the IEEE and chairman of its U.S. Activities Board. Larson opposed the IBM and Apple attorneys at the IEEE executive committee's meeting. "The internal politics of this whole affair are disgusting," he says. "[The IBM and Apple attorneys] didn't argue the merits of the case."

Neither Larson nor Buckley will describe the specific weapon wielded by IBM and Apple; Larson says only that the decision to reverse the filing was made under "extraordinary pressure." Both companies declined comment on the incident.

The question remains: Why would IBM and Apple humiliate one of the industry's most scrupulously objective associations if not to protect themselves against the dire economic consequences of having their own products reverse-engineered?

Buckley claims to be "unhappy" about the outcome but denies that the IEEE has lost any credibility. Larson agrees that the organization's wounds aren't exactly fatal but concedes that "there are a lot of very upset members out there."

—Willie Schatz in Washington, D.C.

MARKETS

New solutions aim to cut cost of high-speed links

SEVERAL SUPPLIERS are addressing the growing demand for components that support transmission rates of a gigabit per second (Gbps) or more in order to reach the segment of the data communications market that isn't being served by 100-megabits-per-second (Mbps) Fiber Distributed Data Interface (FDDI). The high-speed market is being driven by applications such as scientific visualization and powerful graphics workstations.

Such high-speed links do exist, but at prohibitive costs. Developments by IBM, Hewlett-Packard, and start-up Finisar Corp., among others, should slash the cost per connection of gigabit links. In addition, evolving industry standards should provide a framework within which to apply the high-speed technologies. One key standard, Fiber Channel, is being defined under the auspices of the American National Standards Institute; another, serial High Performance Parallel Interface, is a de facto specification backed by many leading communications vendors.

HP this summer introduced a two-

CORRECTION: Electronics exports and imports for 1992 Q1 were incorrectly stated ("Selling abroad gets tougher and trade deficit gets worse," July 1992, p. 7). Exports during the quarter were in fact $18.82 billion, and imports came to $19.53 billion. The trade deficit was correctly stated at $711 million.

chip gigabit-link chipset that encodes and decodes data for transmission rates up to 1.5 Gbps. The chipset must be combined with optoelectronic transmitter and receiver components and other circuitry to build a fully functioning fiber-optic interface. Ron Whitetree, strategic marketing manager for HP's Communications Components division, tells of one HP customer who currently builds custom gigabit-rate interfaces and expects the chipset will lower the cost per connection from $25,000 to about $5,000.

The cost for gigabit interfaces could be cheaper still if the HP chips were combined with the low-cost fiber-optic transmitter and receiver modules Finisar unveiled, claims Finisar president Jerry Rawls. The company bases its components on ordinary compact-disk laser technology, which it has modified to ensure the high reliability rates that gigabit transmissions require.

IBM, meanwhile, has teamed up with HP to develop a family of products based on Fiber Channel, which designates transmission rates ranging from 133 Mbps to 1.062 Gbps. The first jointly marketed product—a $495 interconnect card for workstations and other devices—was designed and built by IBM and supports 266 Mbps rates; the partners will combine forces to create even higher-speed products.

Estimates of the size and potential of the emerging gigabit networking marketplace vary widely. This year, the market for Fiber Channel-like cards (the standard has not yet been ratified) will total just $21 million, estimates Peter Hankin, a partner with research firm Ryan, Hankin, Kent Inc. By 1995, he expects the market to grow to only $65 million. Industry participates say that estimate is far to conservative, even given that the Fiber Channel sector represents just one of several gigabit networking niches. "Everybody wants to go to higher data rates," says Bill Craven, vice president and general manager of the Components Group at HP. "The [overall] market may be many hundreds of millions [of dollars] in three to five years."

—D.D.

MARKETS

How realistic are sunny PCB forecasts?

EVEN IF it's a case of too little, too late, printed circuit board (PCB) manufacturers aren't complaining about their industry's outlook.

Thanks to a rebound in computer and communications end-markets, the $4.8 billion U.S. rigid PCB market is poised to expand shipments by 7.6% this year and 12% next year, say forecasters Ed Henderson and William Loeb. Laminates—the products that go into PCBs—will enjoy 8.7% and 15.3% growth this year and next, with help from 9% to 15% increases in prices due to a reduced supplier base, says Henderson. Fellow forecaster John DeWolf predicts PCB shipments—which include the $370 million flexible circuit market—will rebound from a 1.7% drop last year to 14.3% growth this year, and surge 26.6% in 1993.

Their optimism stems from several trends. First, outsourcing to independent assemblers is growing among OEMs, and the assemblers are looking to outsource their PCBs. "The two trends are inescapable," says Tony Hilvers of the Institute for Interconnecting and Packaging Electronic Circuits. According to Hilvers, last year 66% of OEMs decided to buy, rather them make, PCBs—up from 53% in 1981.

Other factors are more speculative. The marriage of computers and communication technology should surge end-market demand. Consumer electronics manufacturing is expected to come back on shore. And, after a decade of deterioration (see table), PCB makers are hopeful that manufacturing will return to U.S. sites due to a more competitive cost structure as plants become less labor-intensive and more automated.

So far, in the first six months of the year, rigid PCB sales have risen a modest 5%. Phil Lapin of Electronic Market Consulting predicted last December that U.S. producers of PCBs would see only 5% growth in 1992 and 1993. "I'll stand by that forecast till you blow me off the podium," he says. The trend to offshore PCB manufacturing will continue, Lapin believes, especially as the OEM captive producers sell off their PCB divisions and start sourcing worldwide. With more than 1,000 printed circuit board makers four years ago and under 750 now, Lapin expects consolidation to continue. "There's simply no reason for many of them to stay in business," warns Lapin.

—E. B. Baatz

MARKETS

A historical look at world market share for printed circuit boards

	World market ($ millions)	U.S. (% market share)	Japan (% market share)	Europe (% market share)	Rest of world (% market share)
1980 (226Y=$1)	$6,465	40.2%	19.6%	20.3%	19.9%
1988 (125Y=$1)	19,949	29.5	29.2	15.1	26.2
1991 (126Y=$1)	18,974	26.9	34.4	16.0	22.7
1991 (226Y=$1)	$16,126	32.0	23.0	19.0	26.0

Source: IPC

This table shows world market shares for 1980, 1988, and 1991. However, some of the U.S.'s market share decline was due simply to currency fluctuations. The bottom line of the table shows what world market shares would have been in 1991 if the value of the yen had remained at its 1980 level.

COMPUTERS AND OFFICE EQUIPMENT

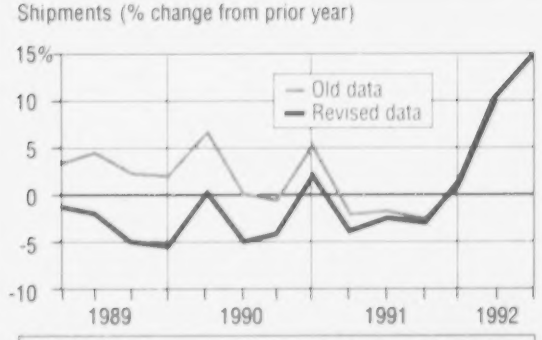
Why this year's big gains are smaller than they look

Computer and office equipment shipments advanced to $17.8 billion in the second quarter of 1992, up 3.9% from the first quarter and 14.7% from a year ago. As a result, Cahners Economics has revised its shipments forecasts upward to 11.4% growth in both 1992 and 1993. But at least a portion of those strong gains is a mirage: The 1991 computer industry recession was much worse than originally thought, according to the latest annual statistical revisions from the U.S. Commerce Department, so much of the big gain was spent just in climbing out of the hole.

Previously, statistics on computer and office equipment shipments showed year-ago losses in four of the five quarters from third-quarter 1990 through third-quarter 1991. Now, the numbers show the industry suffered through nine quarters of year-ago declines starting as early as the first quarter of 1989. So, what number-watchers first viewed as a shorter and milder recession relative to the 1986 downturn was, in fact, longer and deeper.

What's past is past, but one sad fact remains: Industry shipments in the second quarter of this year are only $475 million more than the last three-month high recorded back in the third quarter of 1988. Executives, busy fighting massive price wars, are not surprised at what the government numbers are finally revealing. Without stronger GDP growth, a full recovery from such a rough computer recession won't be easy.

—Madeline Franchi



($ billions)					FORECAST			
Orders	15.1	16.0	16.5	17.3	17.3	17.7	19.3	19.7
Shipments	15.3	16.4	17.2	17.8	17.4	17.6	18.9	19.4
	Q3 1991	Q4	Q1 1992	Q2	Q3	Q4	Q1 1993	Q2

Source: Commerce Dept.; Forecast: Cahners Economics

COMMUNICATION EQUIPMENT

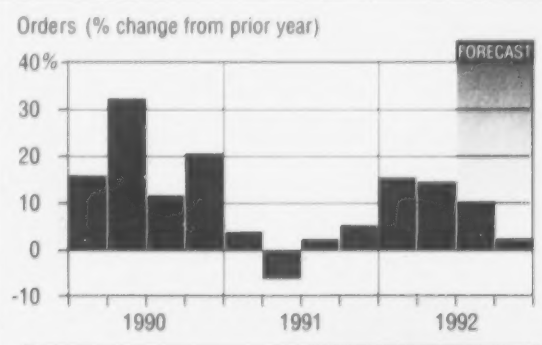
A bright 1992-93 forecast, despite some startling new data

Cahners Economics forecasts communication equipment shipments will advance 6.7% in 1992 and 8% in 1993, which is not much changed from the predictions published last quarter. Second-quarter shipments jumped 8.1% from a year earlier, keeping the rebound on course. Like the computer industry, startling revisions to the historical data by the Commerce Department have painted quite a different picture of the past few years.

The so-called recession-proof communications equipment industry originally reported shipments growth of 18.6% in 1989. Commerce's revisions now show the industry stumbled with a 2.5% decline in shipments instead. According to Commerce, this change stemmed from reporting problems and were related to revisions based on the new Standard Industrial Classification codes instituted about two years ago.

Still, the future looks bright. Orders for communication equipment have posted strong year-ago leaps. The increases have pushed the book-to-bill ratio above 1.00 in three of the past four months, adding to the already healthy backlogs. These demand-side numbers reinforce our confidence in the shipments forecasts.

—M.F.



($ billions)					FORECAST			
Orders	9.7	10.7	10.9	10.8	10.7	10.9	11.3	11.8
Shipments	10.4	10.7	10.9	10.9	11.0	11.2	11.5	11.7
	Q3 1991	Q4	Q1 1992	Q2	Q3	Q4	Q1 1993	Q2

Source: Commerce Dept.; Forecast: Cahners Economics

Due to editing errors, incorrect data were printed in the July 1992 business barometer column (p. 19). To receive a corrected copy of the table and charts, please contact Jean O'Brien at (617) 558-4257, or fax (617) 558-4327.

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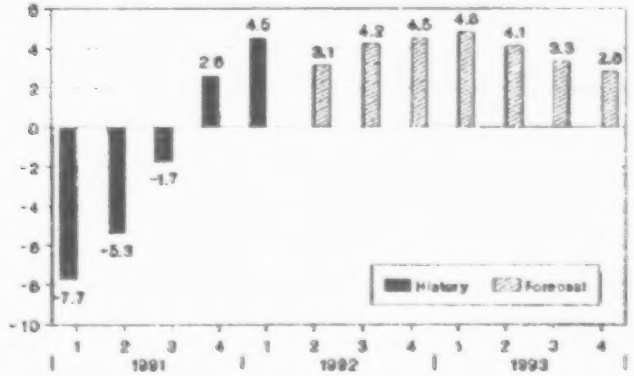
Corrections to charts and data for ELECTRONIC BUSINESS, July 1992, page 19, business barometer column

Measuring & Controlling Shipments
(% change from prior year)

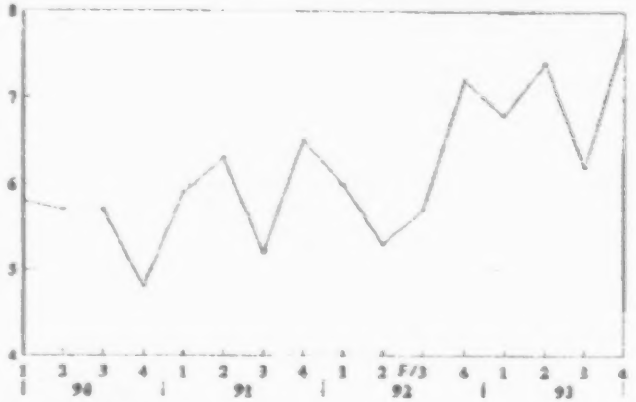


Data: U.S. Commerce Department
Forecast: Cahners Economics

($ billions)

	1991			1992				1993
	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1
Orders	6.87	6.62	7.24	6.88	7.02	7.15	7.45	7.19
Shipments	6.97	6.90	7.17	7.16	7.18	7.19	7.49	7.50
					Forecast.....			

Electronic Component Leadtimes
Delivery time in weeks



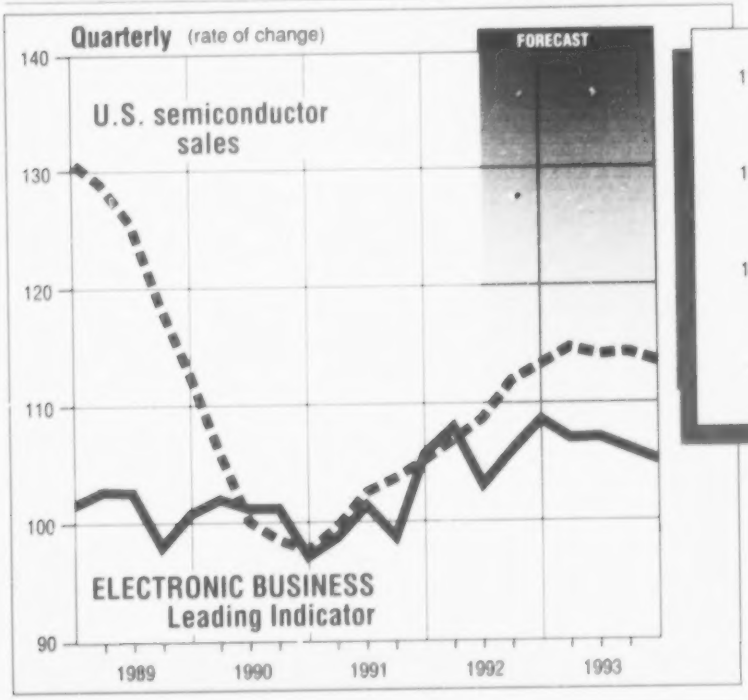
Source: Electronic Purchasing
Forecast: Cahners Economics

($ billions)

	1991			1992				1993
	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1
Orders	15.6	15.7	16.9	15.8	16.7	17.3	19.0	18.0
Shipments	15.9	15.9	16.3	16.1	17.1	17.4	18.1	18.0
					Forecast.....			

CORRECTION

ELECTRONIC BUSINESS Leading Indicator

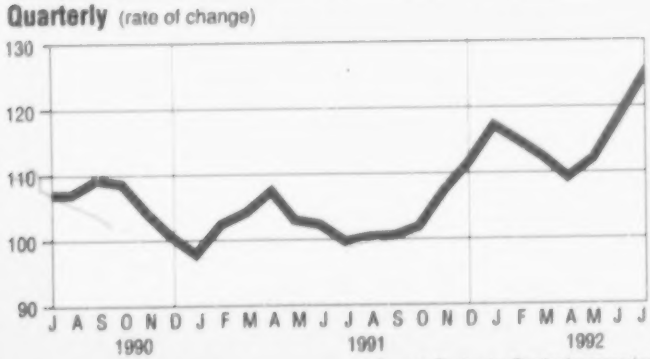


EBLI bounces back, but only slowly

Thankfully, the Electronic Business Leading Indicator (EBLI) jumped to 104.8 in July, which helps to quell fears of a triple-dip industry recession anytime this year. Since its last peak of 110.3 in January 1992, the EBLI had skidded to only 102.3 this past June. Last year, the EBLI began the perennial summer slump with a mark of 98.9 in July—truly cause for concern. This year, it averaged 105.5 during the first seven months and is expected to accelerate through the end of 1992 to a peak of 109.4 in December.

—John Farrell

Growth in chip bookings continue to surge



Source: *Electronics Purchasing* magazine

	Latest month	Previous month	Year ago	1991 average
ELECTRONIC BUSINESS Leading Indicator (rate of change, July)	104.8	102.3	98.9	101.1
U.S. semiconductor bookings ($ millions, 3-month average, July)	$1,599	$1,677	$1,241	$1,311
Weekly hours of semiconductor production workers (monthly average, June)	41.7	42.3	40.8	41.1
Electronic components lead time index (1977 = 100, Aug.)	92.5	102.6	75.3	87.5
S&P's semiconductor stock price index (1970 =10, monthly average, July)	84.3	79.9	68.3	68.5
Change in electronic components inventories ($ millions, SA, June)	$39	-$80	-$46	-$57
Contracts and orders for plant and equipment ($ billions, SA, June)	$34.7	$33.4	$30.7	$33.6

SA = seasonally adjusted; all other data are not seasonally adjusted

Sources: Semiconductor Industry Association, Bureau of Labor Statistics, *Electronics Purchasing* magazine, Standard & Poor's, Commerce Dept., Bureau of Economic Analysis, Cahners Economics

EBLI is a weighted composite of six statistics that lead activity in the electronics industry. To obtain a complimentary background paper, contact Michele Cooper, Cahners Economics, 275 Washington St., Newton, MA 02158-1630, USA; telephone (617) 630-2119; fax (617) 630-2100. For more information about Cahners Economics, call Dan Buchan at (617) 630-2105.

TOP 100

CAPITAL

SPENDERS

Capital budgets shrink, but it could have been worse

The top 100 capital spenders cut investments by 8.8% in 1991. The outlook for 1992 isn't much better

By E. B. Baatz

It's time to face the music, and it sounds more like a dirge than a ditty for capital spending in the electronics industry. After a stately 7.2% gain in capital spending by the industry's top 100 spenders in fiscal 1990, investments in new plant and equipment sagged 8.8% last year. Excluding IBM, which accounts for 35% of the group's total spending, capital investment fell 13%. After adjusting for inflation, the investment record lately looks even gloomier. With only $18.5 billion spent by the 100 most capital-intensive companies last year, spending has retreated to 1988 levels.

The future doesn't hold much promise for a rapid rebound either. With a lagged response to last year's red ink, capital budgets for the top 100 spenders are likely to drop another 5%. That's reminiscent of the 1985-86 recession, when capital spending by the 100 fell during its two-year slump by 8% and 13%. In fact, the ELECTRONIC BUSINESS summer 1992 CFO survey confirms that slow sales and profits growth is continuing to cut into corporate capital budgets. Surprisingly, however, cutting costs have not been the electronics CFOs number-one goal (see sidebar).

Still, the capital-budget cuts could have been—some may say *should* have been—much worse. After all, 1991 was the year that the top 200 electronics companies in the U.S. suffered a 54% plunge in profits—the single worst decline on record. Not unexpectedly, the culprits were the big guys that were so busy restructuring their businesses and recalculating their balance sheets. The six companies in the "diversified electronics" category—IBM, Hewlett-Packard, Honeywell, Harris, Varian, and Mark IV Industries—accounted for more than 42% of all the capital investments made by the top 100 spenders. While the group is dominated by Big Blue's capital

Results of the summer 1992 CFO survey

CFOs say slow sales growth still constrain capital budgets

Slow growth in sales and profits continues to plague electronics companies' capital budgets this summer. So say 122 chief financial officers (CFOs) surveyed in ELECTRONIC BUSINESS's semiannual capital spending poll. In fact, 63% of the CFOs say slow sales and profits remain the biggest constraint to their capital spending plans, nearly unchanged from the 60% who rated that as a factor in a poll conducted six months earlier.

Finance officers have barely altered their spending budgets since last winter. Forty-four percent now plan to increase their capital budgets from fiscal 1991 to 1992, compared with 42% last winter.

Looking ahead to next year, 47% of the CFOs surveyed expect to increase budgets from current levels. Another 15% expect budgets to fall, and the remainder say their company's capital spending will be flat. As a share of revenue, the finance officers indicate capital spending stood at an average 10.3% in 1991, has fallen to 7.7% in 1992, will drop again to 7.3% in 1993, and will remain at 7.3% in 1996.

In an examination of near-term management action items, ELECTRONIC BUSINESS found that CFOs and CEOs appear to be in sync for the most part. Both the CFOs surveyed this summer and CEOs surveyed last fall in the ELECTRONIC BUSINESS/Ernst & Young CEO survey rated "measure customer satisfaction" and "improve commitment to quality" as the two most important management goals. They differed, however, on the third most-important action: CEOs focus on decreasing product cycle times while CFOs are more concerned about reducing current costs.

For complete results of the summer 1992 CFO survey, or to join our financial advisory panel, write ELECTRONIC BUSINESS, 275 Washington St., Newton, MA 02158; Attn: E. Baatz. Fax: (617) 558-4327 □

Most industry segments pulled back on capital spending last year

Industry (# of companies)	% of top 100	Capital spending in fiscal 1991 $ millions	% change from 1990	% of 1991 revenue
Diversified (6)	42.2%	$7,812	-2.2%	8.6%
Semiconductors (11)	10.8	1,998	-15.6	11.5
Communications (11)	8.2	1,514	1.4	10.1
Government (7)	7.8	1,451	-10.2	4.7
Minicomputers (5)	6.0	1,120	-29.7	5.7
Desktop computers (7)	4.2	781	-12.3	4.9
Office equipment (3)	4.2	771	-4.0	3.6
Mainframes (7)	4.0	733	-24.7	5.4
Software (10)	3.2	585	35.9	8.2
Components (9)	3.2	583	7.2	9.5
Peripherals (9)	3.0	544	15.7	5.8
Medical electronics (4)	0.9	171	8.0	6.3
Instruments (4)	0.7	122	-17.0	4.1

The data above excludes seven companies in miscellaneous industry segments

Source: ELECTRONIC BUSINESS

budget, only one company in this segment—Varian—spent more on plant and equipment in 1991 than in 1990. Altogether, the six diversified electronics companies cut capital spending 2%.

Capital budgets for other industry segments were battered even worse than the diversified group. Bombarded by vast changes in their markets and competition from high-powered desktop computer makers, for example, the five minicomputer makers collectively cut their capital budgets by 29.7% last year. Tandem and Digital Equipment led the way by slashing their budgets 54% and 28%, respectively. Unfortunately, those cuts were more than simply a response to falling sales: Capital spending was cut much faster than the decline in revenue. The weighted average of the minicomputer group's capital-spending-to-sales ratio fell from a stellar 8.4% in 1990 to only 5.7% last year.

The ratio of capital spending to revenue is an important one, since mature companies and industries should be spending more relative to revenue today than five years ago. Why? Today's shorter product cycles means stepped-up spending for tooling, explains Benjamin Savidge, chief financial officer for component maker Amp Inc. in Harrisburg, Pa.

Other industries that may be mortgaging their future by cutting capital spending too fast include semiconductors and mainframe computers. Both plundered their capital budgets, by 16% and 25%, respectively.

Mortgaging their futures? Semiconductor, mainframe, and minicomputer makers plundered their capital budgets last year

For the 11 chip companies that make up the semiconductor group, though, a fall in the capital-spending-to-sales ratio from 15.1% in 1990 to 11.5% in 1991 may not be as worrisome as it appears at first glance. The decline was due mostly to Advanced Micro Devices' planned cutback in plant and equipment spending as it wound up development costs for its 386 chip clone and completed its submicron development center.

AMD's 64% cut in capital spending from 1990 to 1991 was surpassed only by an unexpected 67% capital budget cut by a beleaguered DSC Communications. While DSC saw the largest capital spending declines among the 100, many others took big hits, too. Texas Instruments, Unisys, Compaq Computer, and SCI Systems all scrambled to stem last year's overwhelming flow of red ink.

Spending within the U.S. chip industry was led by Intel, which fell only $52 million short of an even $1 billion on capital investments last year. Showing no signs of letting up, the company plans to top $1 billion in capital spending this year.

Some entire industry segments managed to raise capital spending significantly. The best industry for that was software. While those companies aren't typically thought of as big spenders, their total plant and equipment budgets surged 36% from 1990 to 1991, and they spent $585 million last year—more than either the components or the peripherals segments.

The software industry grew plant and equipment spending so rapidly thanks to an acquisition-driven 900%-plus jump in spending by Borland International and another acquisition-driven 209% spending rise by Novell. A 67% increase in capital spending by Microsoft, the software segment's biggest spender, also helped.

Other segments that invested more in plant and equipment in 1991 than in 1990 were peripherals (up 16%), medical electronics (8%), and components (7%). Communications equipment makers also defied the recession by growing capital spending 1.4% to a collective $1.5 billion in fiscal 1991.

Perhaps the most encouraging sign for U.S. electronics makers, albeit not necessarily for U.S. electronics workers, is that companies that are driving hard to tap into markets abroad have been investing more and more in new plants regardless of the recession. For example, both Read-Rite and Dell Computer grew their capital budgets by 535% and 244%, respectively. Thin-film component maker Read-Rite has been busy constructing and equipping a new plant in Thailand, while Dell's entree into Europe meant building a new 136,000-square-foot facility in Limerick, Ireland.

FINANCE & ECONOMICS

TOP 100

SPENDERS

Company location	Capital spending ($ millions)	Rank	1991/1990 change (%)	Rank	Spending/ sales (ratio)	Rank	Spending/net cash flow* (ratio)	Rank	Fiscal year ended
IBM Armonk,N.Y.	$6,497.0	1	+0.2%	48	10.0%	17	188.6%	8	12/91
Motorola Schaumburg,Ill.	1,317.0	2	4.9	41	11.6	13	106.2	17	12/91
Intel Santa Clara,Calif.	948.3	3	39.5	19	19.8	3	76.7	33	12/91
Hewlett-Packard Palo Alto,Calif.	862.0	4	-9.7	61	5.9	51	68.5	37	10/91
Digital Equipment Maynard,Mass.	737.5	5	-28.2	82	5.3	62	349.3	4	6/91
GM Hughes Electronics Detroit,Mich.	681.3	6	-23.0	77	5.9	54	114.7	16	12/91
Texas Instruments Dallas,Tex.	504.0	7	-44.6	95	7.4	36	553.8	1	12/91
Xerox Stamford,Conn.	498.0	8	12.2	36	2.8	90	63.8	41	12/91
Raytheon Lexington,Mass.	348.5	9	-10.8	64	3.8	81	54.9	52	12/91
Amdahl Sunnyvale,Calif.	327.9	10	7.9	39	19.3	5	225.7	7	12/91
AMP Harrisburg,Pa.	313.3	11	-7.4	59	10.1	16	86.4	24	12/91
Microsoft Redmond,Wash.	264.4	12	67.2	13	14.3	8	49.1	60	6/91
Litton Industries Beverly Hills,Calif.	255.1	13	33.5	24	4.9	66	90.0	20	7/91
Pitney Bowes Stamford,Conn.	250.4	14	-22.4	76	7.5	35	59.9	47	12/91
Unisys Blue Bell,Pa.	248.3	15	-46.0	96	2.9	89	-34.5	91	12/91
Honeywell Minneapolis,Minn.	240.2	16	-4.5	55	3.9	79	78.5	32	12/91
Apple Computer Cupertino,Calif.	218.3	17	-2.7	52	3.5	84	47.7	62	9/91
Sun Microsystems Mountain View	192.3	18	-9.7	60	6.0	50	46.7	63	6/91
Compaq Computer Houston,Tex.	188.7	19	-41.9	92	5.8	55	63.7	42	12/91
Tandy Ft. Worth,Tex.	139.5	20	23.9	26	3.1	87	54.8	53	6/91
Tandem Computers Cupertino,Calif.	138.4	21	-54.1	98	7.2	38	70.0	36	9/91
Harris Melbourne,Fla.	133.5	22	-30.9	85	4.4	72	81.9	29	6/91
Wang Laboratories Lowell,Mass.	129.7	23	-15.1	72	6.2	47	-77.2	95	6/91
Advanced Micro Devices Sunnyvale	111.0	24	-63.5	99	9.1	20	38.2	74	12/91
Storage Technology Louisville,Colo.	110.7	25	86.4	9	7.0	40	54.0	55	12/91
National Semiconductor Santa Clara	109.8	26	-39.7	91	6.5	45	508.3	3	5/91
Molex Lisle,Ill.	109.2	27	50.2	17	15.4	7	89.3	21	6/91
Loral New York,N.Y.	93.1	28	52.0	16	4.4	73	55.3	51	3/91
Intergraph Huntsville,Ala.	91.6	29	15.0	32	7.7	33	65.8	38	12/91
Seagate Technology Scotts Valley,Calif.	90.9	30	-11.2	66	3.4	85	39.9	73	6/91
Conner Peripherals San Jose,Calif.	87.7	31	-7.4	58	5.5	57	61.5	45	12/91
Novell Provo,Utah	86.9	32	209.0	4	13.6	9	46.5	64	10/91
Data General Westboro,Mass.	82.8	33	-2.7	53	6.7	42	43.2	67	9/91
Western Digital Irvine,Calif.	76.9	34	-11.0	65	7.8	31	-95.7	96	6/91
LSI Logic Milpitas,Calif.	73.7	35	18.8	30	10.6	15	80.7	30	12/91
Tektronix Beaverton,Ore.	67.9	36	-30.0	84	5.1	64	64.4	39	5/91
Beckman Instruments Fullerton,Calif.	67.5	37	0.3	47	7.9	28	78.6	31	12/91
Applied Materials Santa Clara,Calif.	67.5	38	-39.2	90	8.0	25	133.1	11	10/91
Medtronic Minneapolis,Minn.	65.8	39	19.1	29	6.4	46	36.6	76	4/91
Cypress Semiconductor San Jose,Calif.	64.8	40	77.1	11	22.6	1	85.6	26	12/91
Oracle Systems Redwood Shores,Calif.	60.7	41	-32.0	86	5.9	53	104.1	18	5/91
Varian Associates Palo Alto,Calif.	59.7	42	8.6	38	4.3	74	63.9	40	9/91
Komag Milpitas,Calif.	54.4	43	20.4	28	19.5	4	121.4	12	12/91
Analog Devices Norwood,Mass.	52.3	44	36.8	20	9.7	18	85.8	25	10/91
E-Systems Dallas,Tex.	52.1	45	-13.4	69	2.6	93	38.1	75	12/91
Micron Technology Boise,Idaho	52.0	46	-34.9	87	12.2	12	54.5	54	8/91
Silicon Graphics Mountain View,Calif.	47.2	47	59.5	15	8.6	21	74.8	35	6/91
Cray Research Eagan,Minn.	46.7	48	-25.5	79	5.4	58	14.7	86	12/91
Maxtor San Jose,Calif.	46.3	49	3.6	42	5.3	61	320.1	5	3/91
Quantum Milpitas,Calif.	46.0	50	175.8	5	5.2	63	53.4	57	3/91

(continued)

TOP 100

CAPITAL SPENDERS

Company Location	Capital spending ($ millions)	Rank	1991/1990 change (%)	Rank	Spending/ sales (ratio)	Rank	Spending/net cash flow* (ratio)	Rank	Fiscal year ended
Lotus Development Cambridge,Mass.	$38.8	51	-24.8%	78	4.7%	69	34.1%	80	12/91
Zenith Electronics Glenview,Ill.	36.7	52	13.3	34	2.8	91	-267.9	99	12/91
Applied Magnetics Goleta,Calif.	35.7	53	-10.6	63	7.8	29	317.8	6	9/91
Read-Rite Milpitas,Calif.	35.6	54	535.3	2	20.1	2	120.1	13	9/91
Integrated Device Tech. Santa Clara	35.6	55	1.6	45	17.9	6	117.6	15	3/91
Control Data Minneapolis,Minn.	32.9	56	-14.8	71	2.2	95	35.6	78	12/91
VLSI Technology San Jose,Calif.	32.8	57	-7.0	57	7.9	27	56.3	49	12/91
Dell Computer Austin,Tex.	32.6	58	244.0	3	3.7	82	50.4	58	1/92
Stratus Computer Marlborough,Mass.	31.5	59	14.9	33	7.0	39	35.1	79	12/91
Mentor Graphics Wilsonville,Ore.	31.2	60	-10.4	62	7.8	30	-73.9	94	12/91
SCI Systems Huntsville,Ala.	30.3	61	-51.6	97	2.7	92	75.1	34	6/91
Cadence Design Systems San Jose	29.6	62	33.6	23	7.6	34	185.0	9	12/91
Perkin-Elmer Norwalk,Conn.	29.3	63	103.5	7	3.3	86	519.5	2	7/91
Borland Intl. Scotts Valley, Calif.	28.2	64	902.8	1	12.4	10	85.1	27	3/91
Vishay Intertechnology Malvern,Pa.	26.7	65	-13.7	70	6.0	48	55.6	50	12/91
3Com Santa Clara,Calif.	26.6	66	3.2	44	6.7	43	-532.4	100	5/91
Sequent Computer Beaverton, Ore.	26.3	67	-44.5	94	12.3	11	-127.7	98	12/91
Pyramid Technology Mountain View	26.1	68	1.4	46	11.5	14	83.6	28	9/91
Andrew Orland Park,Ill.	25.0	69	-0.6	49	6.0	49	58.9	48	9/90
ADC Telecom Minneapolis, Minn.	24.6	70	78.9	10	8.4	24	61.4	46	10/91
Teradata El Segundo,Calif.	24.4	71	-29.0	83	9.5	19	98.7	19	6/91
Westmark Seattle,Wash.	24.0	72	25.3	25	4.7	68	61.7	44	12/91
Sprague Technologies Stamford,Conn.	22.7	73	48.4	18	7.7	32	-63.1	93	12/91
Savin Stamford,Conn.	22.5	74	-38.1	88	7.2	37	-32.2	90	12/91
DSC Communications Plano,Tex.	22.3	75	-67.2	100	4.8	67	-56.8	92	12/91
SynOptics Communications Santa Clara	20.9	76	-1.4	50	8.4	23	53.7	56	12/91
Avnet Great Neck,N.Y.	20.4	77	17.2	31	1.2	100	31.4	81	6/91
Scientific Atlanta Atlanta,Ga.	19.9	78	-27.2	81	4.0	77	139.6	10	6/91
Mark IV Industries Amherst,N.Y.	19.8	79	-5.3	56	2.1	96	41.0	71	2/91
EMC Hopkinton,Mass.	19.7	80	21.1	27	8.5	22	88.1	23	12/91
Computer Associates Garden City,N.Y.	19.2	81	-15.8	73	1.4	99	7.5	87	3/91
M/A-Com Wakefield,Mass.	17.2	82	-1.9	51	4.5	71	41.5	70	9/91
Symbol Technologies Bohemia,N.Y.	17.2	83	12.6	35	5.4	59	48.8	61	12/91
Dynatech Burlington,Mass.	16.8	84	11.8	37	3.5	83	43.7	66	3/91
Micropolis Chatsworth,Calif.	16.4	85	88.2	8	4.7	70	63.2	43	12/91
CTS Elkhart,Ind.	16.0	86	35.1	21	7.0	41	118.5	14	12/91
Teradyne Boston,Mass.	14.6	87	-39.1	89	2.9	88	26.5	83	12/91
Cabletron Systems Rochester,N.H.	14.5	88	34.9	22	8.0	26	36.5	77	2/91
Augat Mansfield,Mass.	14.2	89	-20.4	75	5.1	65	-107.2	97	12/91
Sensormatic Deerfield Beach,Fla.	14.2	90	76.4	12	5.9	52	46.3	65	5/91
International Rectifier El Segundo,Calif.	14.2	91	155.8	6	5.6	56	49.1	59	6/91
Acuson Mountain View,Calif.	13.8	92	-17.2	74	4.1	76	20.1	85	12/91
Legent Vienna,Va.	13.6	93	3.5	43	6.7	44	28.9	82	9/91
Adobe Systems Mountain View,Calif.	12.2	94	65.0	14	5.3	60	20.2	84	11/91
Bolt Beranek and Newman Cambridge	10.8	95	-3.7	54	4.0	78	40.3	72	6/91
Everex Systems Fremont,Calif.	10.4	96	6.1	40	2.4	94	-27.1	89	7/91
Fluke Mfg., John Everett,Wash.	10.1	97	-11.5	67	4.2	75	89.2	22	9/91
ESCO Electronics St. Louis,Mo.	10.0	98	-43.1	93	2.1	97	-21.7	88	9/91
Amphenol Wallingford,Conn.	10.0	99	-13.1	68	2.0	98	42.9	69	12/91
Datapoint San Antonio,Tex.	10.0	100	-27.0	80	3.8	80	43.0	68	7/91

*Capital outlays to net cash flow after dividends

List includes only EB 200 companies that generate 50% or more of their total revenue from electronics sales

Source: ELECTRONIC BUSINESS

Fragmenting memory market offers second chance to U.S. test vendors

Japan still dominates this $300 million market, but U.S. strength in flexible testers is a better match for new market needs

By Gil Bassak

The changing shape of memory devices is making the toughest design job in the test business even tougher. Vendors of automatic test equipment (ATE) have always struggled to develop machines capable of testing the latest memory chips—the densest of all IC's. Now, a proliferation of new device types has created new requirements that threaten to fundamentally alter the look of this $300 million market.

Here's the problem. Rather than just sell standard-configuration DRAMs, SRAMs, and other memories, device makers are selling an increasing variety of "specialty RAMs" in an effort to differentiate their products for emerging applications such as multimedia and notebook computing. There are video RAMs, application-specific RAMs, and memories with on-board logic to speed access time. There are even higher-capacity 8- and 16-megabit memories with configurable I/O data paths so they can be used for applications with lower data path widths.

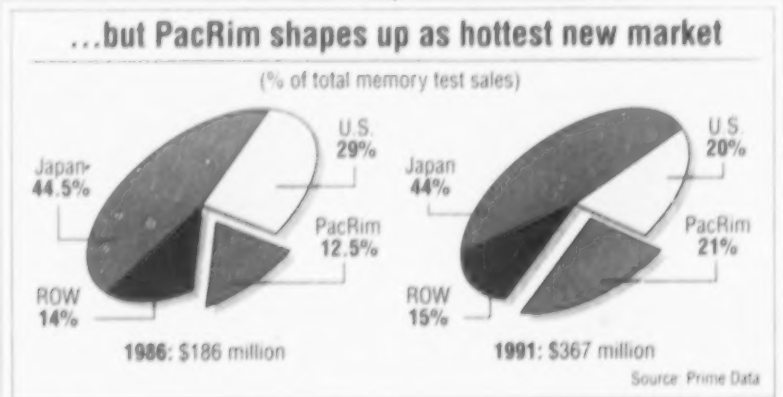
"NEC now has 300 to 400 different DRAMs in its catalog," notes Dan Hutcheson of San Jose-based VLSI Research Inc. "A few years ago, there were five or six."

This increased diversity is scattering ATE vendors' finely tuned business plans to the wind. Rather than design racehorse machines engineered to test a handful of standard chips as rapidly as possible, they must create more flexible, versatile products. And while vendors could safely plan on spending the $45 million or so it typically takes to bring a next-generation memory tester to market, this proliferation of device types will throw the predictable two-to-three year cycle between DRAM generations off schedule.

"Before, we basically knew what kind of tester to design, but even the memory manufacturers don't know where the market will be three years from now," says Mark Allison, director of memory product marketing for Megatest Corp. in San Jose. "It's much more of a gamble for ATE companies now. In the end, whoever makes the best guess will win."

But the odds aren't exactly even. In fact, Megatest and Boston-based Teradyne Inc., the last surviving U.S. vendors of memory testers, suddenly hold trump cards in the form of new products that are designed for greater flexibility. These products feature tester-per-site architectures that allow customers to test more than one device at a time. Meanwhile, Japanese market leaders such as Advantest Corp. and Ando Corp. continue to push the straightaway speed of their shared-resource architecture machines.

"The U.S. vendors have taken back the technical high ground," says VLSI's Hutcheson. "That doesn't always translate into commercial success, because customers have shown that they are willing to live with older testers, but the U.S.



companies have now merged back into the stronghold."

Indeed, efforts to build market share have been slowed by the dismal state of the market in general. Drastic cuts in capital spending by Japan's chip houses should cause memory test revenues to fall from $367 million in 1991 to about $300 million this year, says market researcher Ken Neff with Prime Data in San Jose—the third year of decline in a row.

Still, Megatest and Teradyne have both grown faster than their top Japanese competitors, says Hutcheson—in itself a remarkable turnaround for a U.S. industry left in shambles in the wake of the Japanese invasion of the memory chip market in the 1970s. In fact, it seemed certain the U.S. would be left unrepresented until Teradyne shocked the market by unveiling a new model in 1987. The company has now climbed back to second place with a 16% market share, still far behind Advantest at 39%.

Customers confirm forecasts of a U.S. resurgence in memory test. "We are impressed with how far [the U.S. vendors] have come," says Marvin Strong, a test department manager with memory maker Micron in Boise, Idaho. Admitting that he is "absolutely partial" to American vendors, he is optimistic that they can provide a product that is at least as good, if not better, than the Japanese competitors. "We find them flexible and eager to work with us, and there are no communication or competitive barriers."

Japanese competitors, for their part, recognize the threat but downplay it. "Sure, we'll lose sometimes," says Larry Debattista, manager for technical information services for Advantest America. "But not often."

How much ground can be made up? Ed Rogas, vice president and general manager of Teradyne's chip test division, feels his company can increase its memory market share to 30% by 1995. That may be ambitious, as makers of the largest volume devices served by Japan's rocket-fueled testers will most likely not be swayed by the added flexibility.

There is another advantage awaiting the U.S. vendors, however, says Prime Data's Neff. With much DRAM production moving from Japan to the Pacific Rim, U.S. vendors will face fewer "cultural impediments," such as the close *keiretsu* relationships the major Japanese vendors enjoy with major IC houses. Neff says that memory tester sales to the Pacific Rim nations have increased from 0.5% of the market in 1980 to 18% in 1990, making it the world's fastest-growing regional market. "The key limit on growth is the region where the devices are produced," confirms Rogas. "As the memory business goes away from Japan, it will be easier for us." Korea has been especially fruitful with large sales to Samsung, Goldstar, and Hyundai, he says.

Cost is also a key to greater market share, however. Faced with their own skyrocketing development costs, fierce competition, and cyclical markets, memory makers are in no mood to pay a premium for new machines. Top-of-the-line production testers often cost upwards of $1.5 million, and some studies claim that test already chews up as much as a third of a DRAM's total cost.

Micron's Strong, for one, is not rushing to buy a new machine. The company's policy is to buy only testers that can handle at least one generation into the future, and Strong's team is currently working to extend their current machine to its third

ATE's struggle with device diversity

As DRAMs progressed in capacity from 256 kilobits to 1, 4, and—by next year—16 megabits, applications have forced the I/O data path to expand from 1 bit to 4, 8, and 16 bits wide. Now, device vendors are taking advantage of the added capacity by offering configurable devices that let customers choose the I/O data path they require. Laptop and notebook computer makers, for example, will be able to reduce their chip count by using high-capacity DRAMs with low-width I/O paths—a fundamental advantage that slashes space, power requirements, and operating temperature.

Unfortunately, the increased flexibility and density of these devices reduces the machines' capacity to test chips in parallel, thereby reducing throughput. Greg Armstrong, manager of application specific memory products with Dallas-based Texas Instruments, sees the effect of increasing I/O width like this: "We've been sending 64 skinny people through a doorway, but suddenly some of them are four times as wide." What that means for the tester, he adds, is that it must be able to reconfigure itself to handle devices of various widths. In practice, it means testers must be programmable and reconfigurable on the fly.

To make matters worse, DRAM makers are adding logic circuitry to their wares to match the speed gains achieved by microprocessor makers in recent years. Armstrong reports that TI, for example, is building DRAMs that run as fast as 100 megahertz. That's great for TI's customers, but tough on testers. "Relatively narrow, slow-poke devices are turning into very wide, blazingly fast devices, and DRAM testers will need to handle that." However, that requires a level of flexibility that DRAM ATE vendors are unaccustomed to delivering, he says. □

"Relatively narrow, slow-poke devices are turning into very wide, blazingly fast devices, and DRAM testers will need to handle that," says TI's Greg Armstrong

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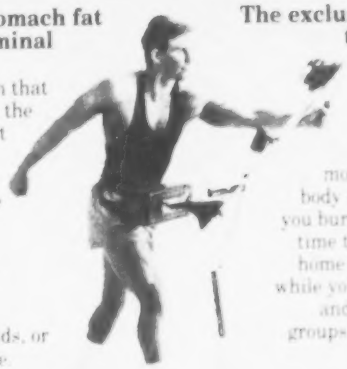

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MARKETS

DRAM generation. In the meantime, they search for a product that can test memories with 4-gigabit capacity.

How can ATE vendors deliver new products and not price themselves out of the market? For one, customers say they must spend engineering dollars to create upgradable machines that could meet changing requirements—a big change in philosophy for ATE's old-school ironmongers. "The tester maker sees his job as convincing you that the time to buy a new tester is now," says Tom Thorpe, manager of worldwide quality and reliability assurance for Dallas-based memory maker Texas Instruments Inc. "An upgrade is a lot cheaper, but it doesn't hack it for them." Maybe it should. As things stand now, most DRAM makers still maintain in-house test groups to make equipment where commercial vendors fall short.

ATE vendors must also use technology to drive down cost rather than to always push performance. Teradyne, for example, decreased the price of its new J990 series by leveraging the proprietary E/MOS technology developed for its J971 VLSI chip tester. This design, which replaces expensive and power-hungry ECL technology with more efficient CMOS technology for 90% of the critical circuitry, reduced the cost of the J971 from over $11,000 per pin for the previous generation to less than $8,000 per pin. In the J990, the E/MOS technology allowed designers to reduce the total parts count by over 90%.

Another cost-saving option is to buy canned pin electronics solutions from commercial IC suppliers such as Analog Devices Inc. and Brooktree Corp. While most ATE makers still design their own, ATE marketing manager Bill Gotschewski says ADI has added an average of one of ATE's small coterie of vendors to its customer list each year since it began addressing the market in 1986. Armed with skilled IC design staffs and robust production processes, these vendors say they can provide the speed and reliability required to help test emerging device types—and fit the ever-increasing number of pins into ever-shrinking footprints. ☐

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VIEWPOINT

Forget dogma. Let's choose an industrial policy for the times

If you haven't read the roundtable discussion among seven senior executives in this issue of ELECTRONIC BUSINESS, do so now. Honest. The topic is government involvement in our industry. Throughout the discussion, you can hear their ambivalence about how much individual control they can exert over their companies' futures, about how much of their futures are wrapped up in joint efforts within the corporate world, and about how much of it depends on government action.

These are hard questions, largely because the answers vary with time. Real life is never stable. Boom times give way to recessions or stagnations in an endless but not orderly or easily predictable cycle. Change—trite though it sounds—is indeed the constant and the relationship between government and industry must change to match the times.

Today, we need a closer relationship between the two. We need a clearly articulated industrial policy. That policy, whatever its particulars are, should focus on the renewal side of the economic cycle. It should aggressively tackle the jobs of increasing work force competence, increasing capital formation, and stimulating the creation of new companies. It must also recognize the realities of the global market.

Frankly, many of these changes directly threaten established businesses. Too many of the giants are no longer jobs-creation and wealth-creation machines. Many are at the tail end of the economic cycle. Downsizing may be good and proper for them, but it is not particularly buoyant for the economy as a whole.

How do we, as individuals and as an industry, help bring about these needed changes? As the jointly sponsored ELECTRONIC BUSINESS/American Electronics Association roundtable discussion indicates, we must influence the political process. We must make business issues, in very specific form, become part of the core of the election debate. We must not be dogmatic. We must understand that the proper relationship between government and business changes. We must debate what that change should be and we must recognize that, whatever formula we come up with for the next decade, it isn't a permanent solution. It's simply a match for the times.

—John Russell, editor

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